Compressed Natural Gas Workshop

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Natural Gas Quality:
Power Turbine Performance
During Heat Content Surge

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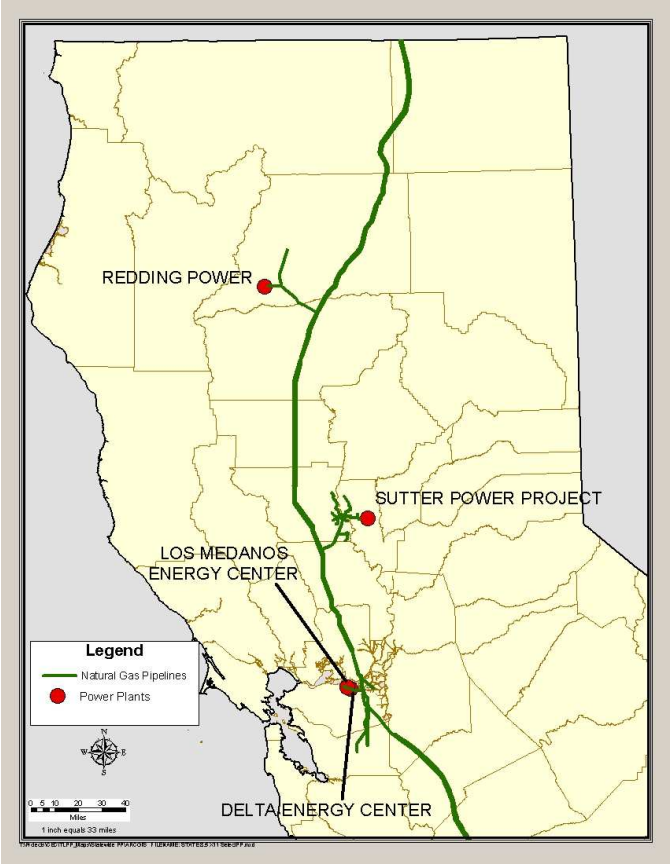
Sponsored by the California Energy Commission

Summary of Findings

- Uncontrolled NOx emissions increase with increasing natural gas heat content, but that increase is different for each turbine.
- Controlled NOx was not found to increase, the emission controls were able to compensate
- Additional ammonia was used for the gas turbines with Selective Catalytic Reduction in order to compensate.
- Additional data is necessary to determine full impact to the natural gas fired power plants.

Natural Gas Excursion Event

- PG&E pipeline coming from Canada experienced heat content excursion for three days.
- Heat content excursion due to outage at a liquids extraction plant in Canada.
- Operating and fuel data from four power plants were obtained around the excursion event.



Power Plant Descriptions

- **All of the power plants that were monitored are combined cycle power plants.**
- **Redding is a "muni", while Sutter, Delta and LMEC are Calpine owned merchant plants.**
- **Specific Plant Turbine and Emissions Control Descriptions are provided below.**

Facility	Turbine Type (Number)	MW (Turbine/Plant)	Emission Control Technologies
Redding	Alstom GTX100 (1)	43/56 (Unit 5 only)	SCONOx
Sutter	Westinghouse 501FD (2)	175/540	DLN, SCR, and Oxidation Catalyst
Delta	Westinghouse 501FD (3)	175/861	DLN, SCR
LMEC	General Electric 207FA (2)	172/555	DLN, SCR, and Oxidation Catalyst

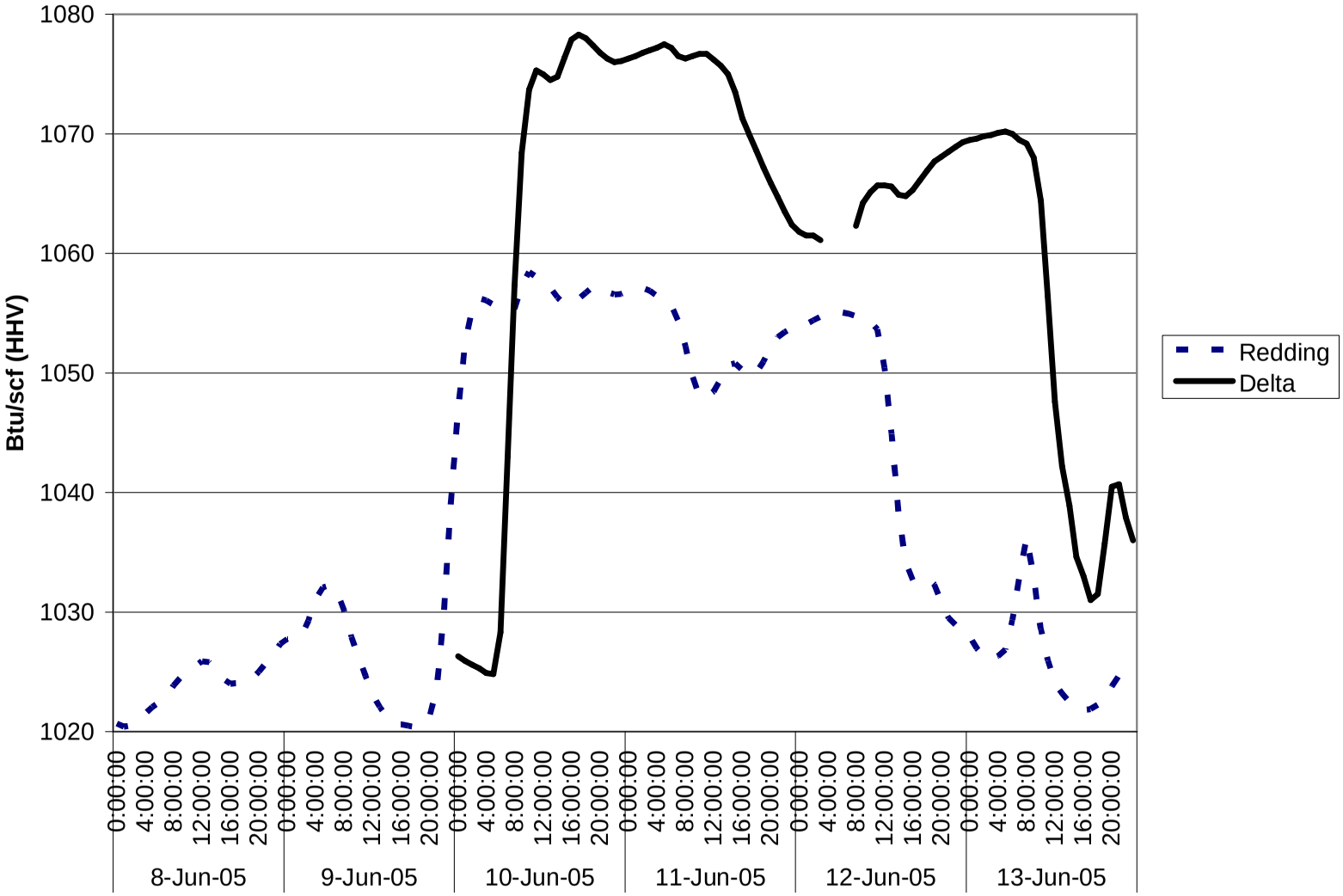
Power Plant Data

	Natural Gas Data			Performance Data					Exhaust Data					
Facility	Btu Content (as used)	Pipeline Gas Hydrocarbon Composition	Pipeline Gas Inert Composition	Heat or Fuel Input	MW Output (GT only)	Efficiency Est.	Ammonia Flow	Process Status	Uncontrolled NOx	Controlled NOx	Controlled CO	Oxygen Content	Turbine/Stack Exhaust Temperatures	SCR Catalyst Temperature
Redding	X	-	-	X	-	-	N/A	X	X	X	X	X	-/-	N/A
Sutter	X	- [1]	-	X	X	-	X	X	X	X	X	X	X/X	X
LMEC	X	X [2]	X [2]	X	X	X	X	-	-	X	X	X	X/-	-
Delta	X	X [2]	X [2]	X	X	X	X	-	-	X	X	X	X/-	-

1 – Data supplied includes blended gas composition data.

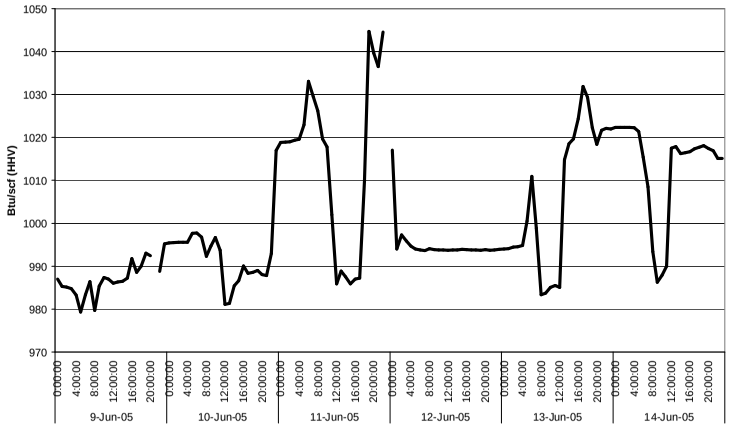
2 – Data supplied from PG&E pipeline adjacent to Delta gas blending facility, but blended gas composition data for Delta was not supplied.

Pipeline Natural Gas Heat Content

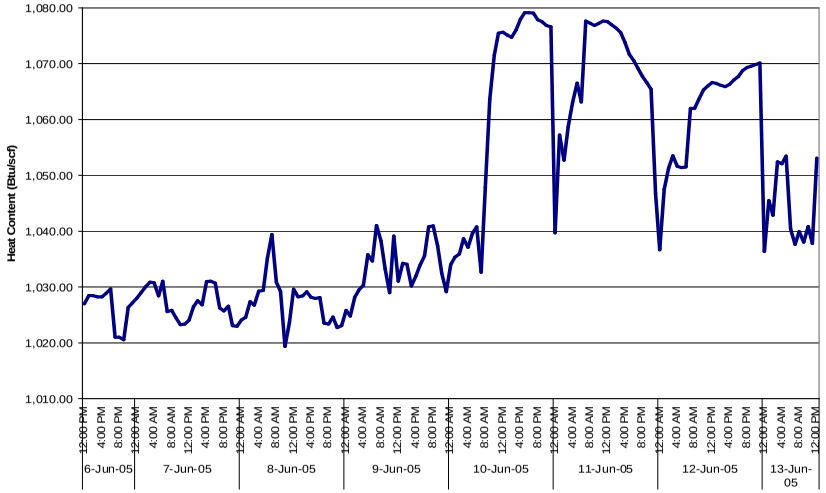


Turbine Fuel Heat Content Variability

- **Sutter Fuel Data**

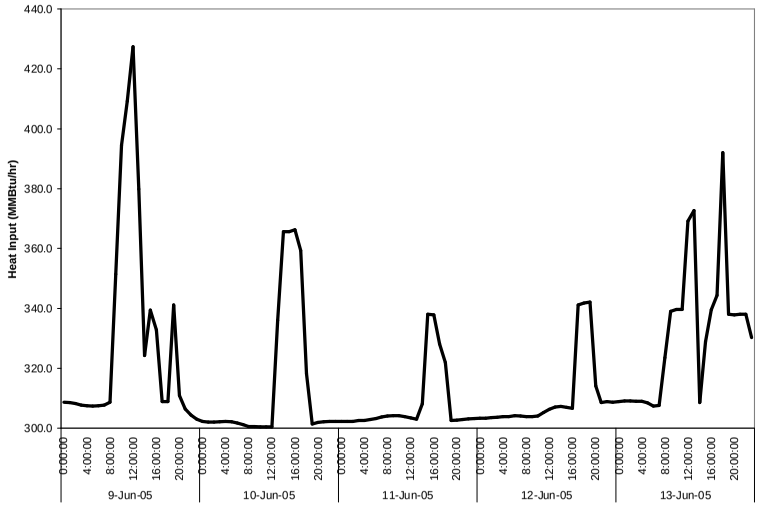


- **LMEC Fuel Data**

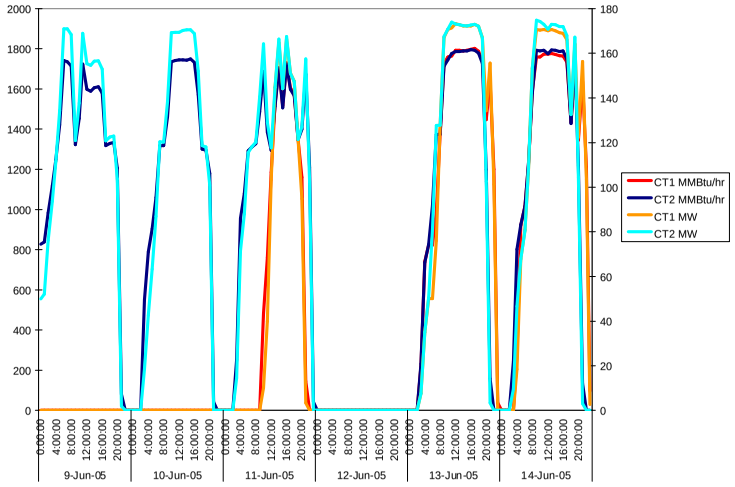


Gas Turbine Load Variability

- **Redding Turbine**

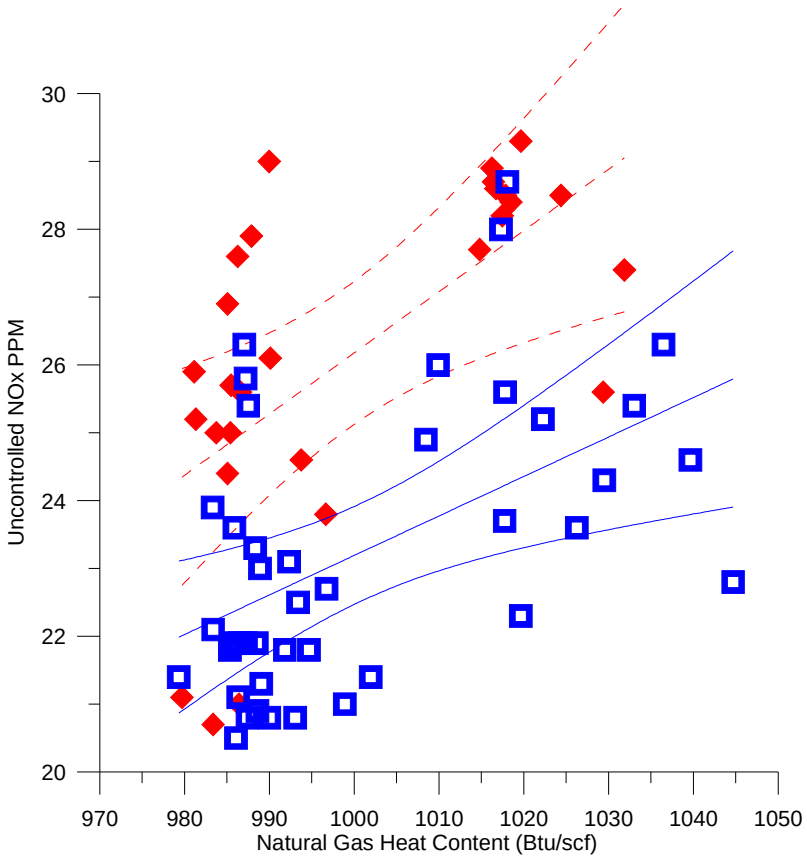


- **Sutter Turbines**

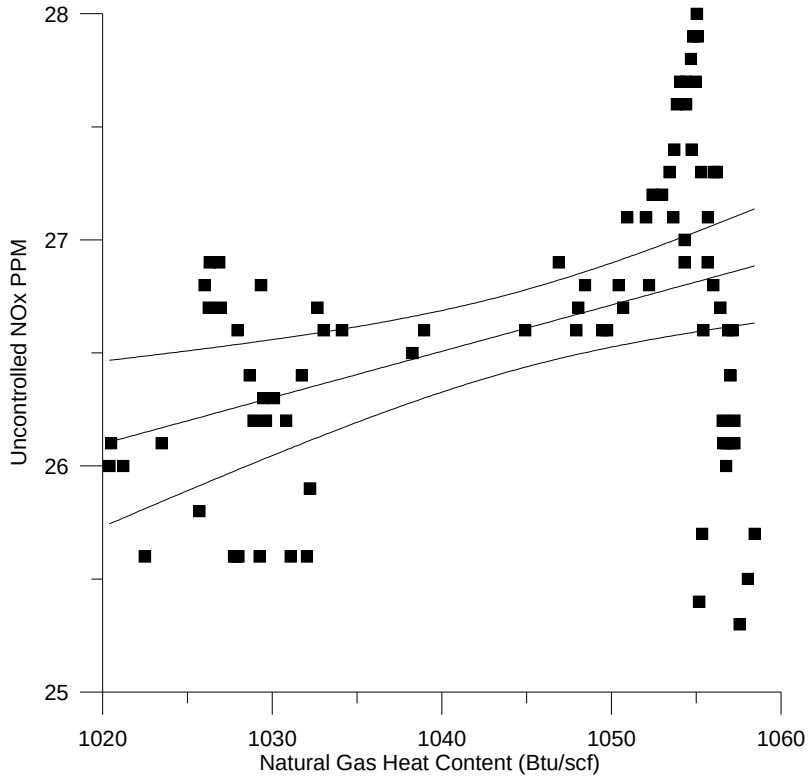


Uncontrolled NOx Emissions vs. Heat Content

Sutter Turbine 2

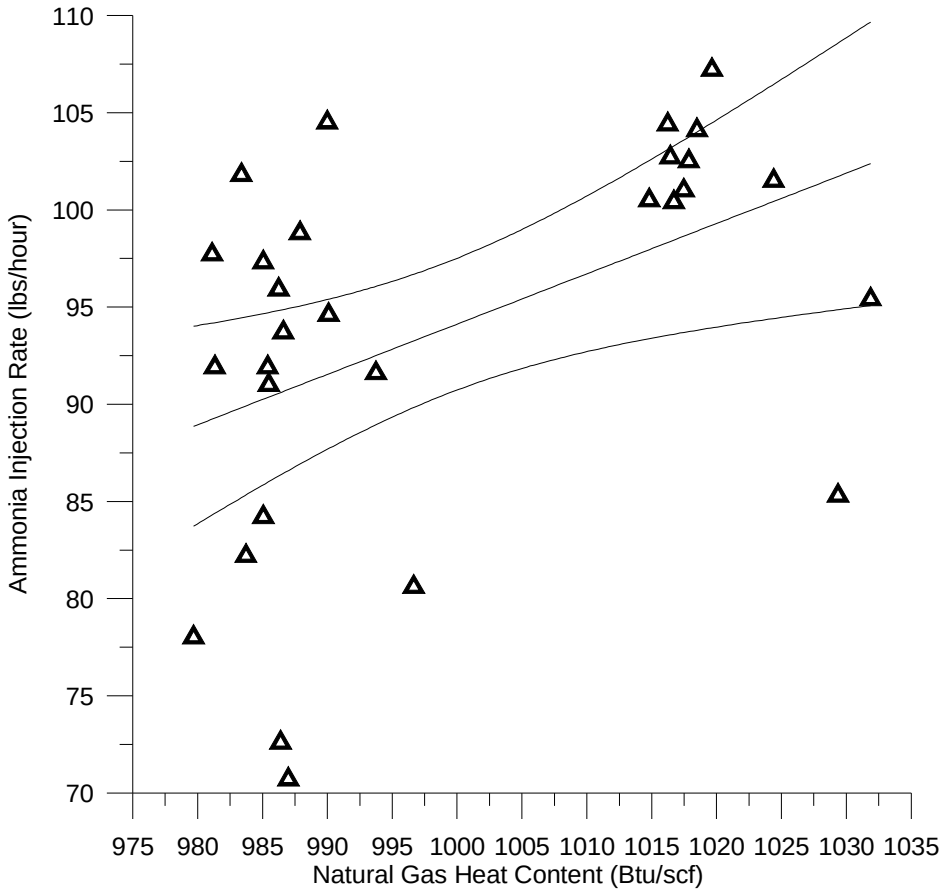


Redding



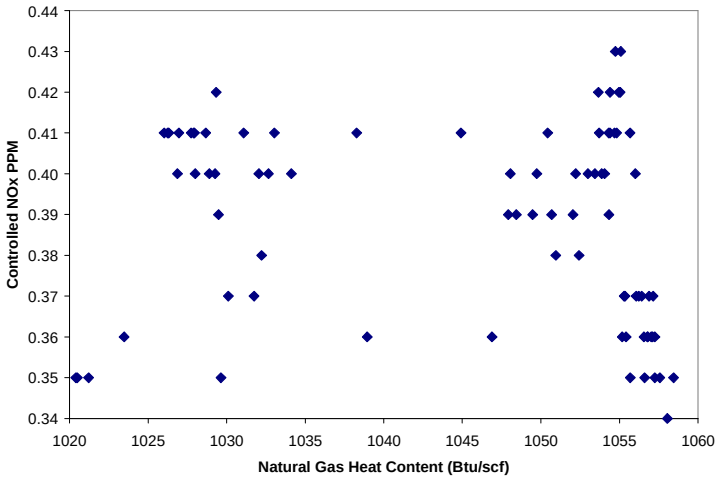
Ammonia Consumption

- **Sutter Turbine 2 ammonia injection rate vs. natural gas heat content at near similar operating loads**

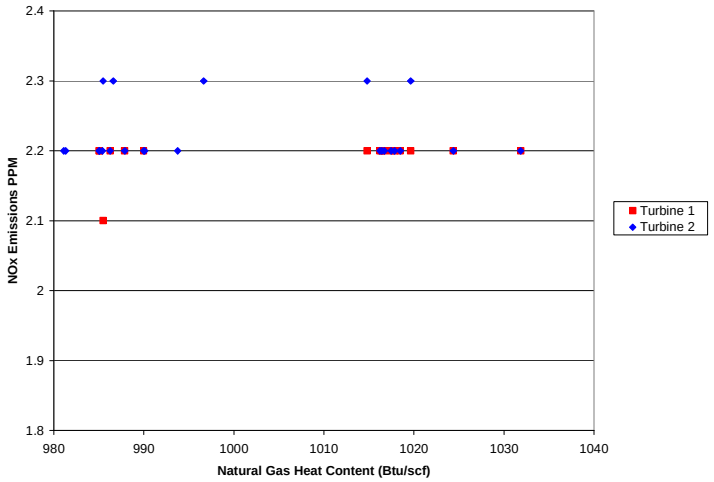


Controlled NOx Emissions vs. Heat Content

Redding Controlled NOx



Sutter Controlled NOx



Conclusions

- **Results of this study may not apply to all newer combined cycle gas turbine facilities; particularly different turbine models/makes and those with different combustors.**
- **Additional data from other combined cycle plants, including any 7F turbine base load plants, should be collected when similar natural gas heat content excursion events occur.**
- **Additional data from simple cycle plants should be collected.**
- **Additional data from other older facilities that make up the bulk of the current natural gas fired power plant emissions (i.e. cogeneration units, perhaps even steam boilers).**